



Open Ended Investigation

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Assessment Task 1

Teache

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18

Time Allowed 35 minutes (plus 5 minutes reading time)

You are only able to use data that is contained in the box collected during the Investigation.

Please utilise the reading time. Read ALL questions carefully before commencing.

1. Present your results for all data collected for the molar heat of combustion of ethanol in a data table. (5 marks)

| Equipment set-up | Molar Heat of Combustion of Ethanol | | | | | | | | | |
|-------------------------------|-------------------------------------|----------------|--------------------------------|------------------------------|--------------------------|--------------------------|------------------------|---------------------------|------------------------------------|------------------------------------|
| | Trial | Mass water (g) | Initial water Temperature (°C) | Final water Temperature (°C) | Δ water Temp (°C) | Initial Ethanol mass (g) | Final Ethanol mass (g) | Δ Ethanol mass (g) | ΔH (kJ mol ⁻¹) | ΔH (kJ mol ⁻¹) |
| Retort stand with calorimeter | 1 | 50 | 25 | 40.0 | 15 | 267.6 | 266.8 | 0.8 | / | / |
| | 2 | 50 | 24 | 39.0 | 15 | 266.8 | 265.9 | 0.9 | / | / |
| | 3 | 50 | 23 | 41.0 | 23 | 285.9 | 285.0 | 0.9 | / | / |
| | Av | 50 | 24 | 41.7 | 18 | 800.3 | 265.9 | 0.9 | 185.0 | 4.02 |
| Tripod with calorimeter | 1 | 50 | 23 | 27.0 | 4 | 255.4 | 254.7 | 0.7 | / | / |
| | 2 | 50 | 24 | 29.0 | 5 | 254.7 | 253.9 | 0.8 | / | / |
| | 3 | 50 | 24 | 30.0 | 6 | 253.9 | 253.0 | 0.9 | / | / |
| | Av | 50 | 23.7 | 28.7 | 5 | 254.7 | 253.9 | 0.8 | 61.76 | 1.34 |
| Retort stand with beaker | 1 | 50 | 23 | 41.0 | 18 | 253.0 | 252.2 | 0.8 | / | / |
| | 2 | 50 | 24 | 38.0 | 14 | 252.2 | 251.5 | 0.7 | / | / |
| | 3 | 50 | 24 | 32.0 | 8 | 251.5 | 250.6 | 0.9 | / | / |
| | Av | 50 | 23.7 | 37.0 | 13 | 252.2 | 251.3 | 0.8 | 183.5 | 3.55 |

2. Showing full working, calculate the molar heat of combustion of ethanol for the most accurate experiment. (The molar heat of combustion of ethanol is 1367 kJ mol⁻¹). (5 marks)

Most accurate experiment was #1, retort stand with calorimeter

$$q = mc\Delta T$$

$$= 50g \times 4.18 \text{ kJ g}^{-1} \text{ K}^{-1} \times 17.7 \text{ K}$$

$$= 3.70 \text{ kJ}$$

$$n(\text{C}_2\text{H}_5\text{OH}) = \frac{0.9g}{46.06 \text{ g/mol}} = 0.020 \text{ mol}$$

$$\Delta H = \frac{3.70 \text{ kJ}}{0.020 \text{ mol}} = -185 \text{ kJ/mol}$$

$$\Delta_c H = 1.9 \times 10^2 \text{ kJ/mol}$$

$$= 185 \text{ kJ/mol}$$

✓

5

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Open Ended Investigation

Number: .

Assessment Task 1

Teacher: .

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186

Time Allowed 35 minutes (plus 5 minutes reading time)

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Please utilise the reading time. Read ALL questions carefully before commencing.

1. Present your results for all data collected for the molar heat of combustion of ethanol in a data table. (5 marks)

Molar heat of combustion of Ethanol

| Set-up | Mass of Ethanol (g) | Temp. of Water (°C) | | | Mass of water (g) | Heat Released Combustion | |
|------------------|---------------------|---------------------|-------|------------|-------------------|--------------------------|----------------|
| | | Start | End | ΔT | | Temp (°C) | $kJ\ mol^{-1}$ |
| Calorimeter | 1 | 23.82 | 27.12 | 10 | 23 | 60 | 15° |
| and Retort Stand | 2 | 23.82 | 27.12 | 5.4 | 23 | 23 | 42 |
| Ave | - | - | - | 2.75 | - | - | 40 |
| | | | | | | | 50 |
| | | | | | | | 8.4 |
| Burette | 1 | 23.12 | 27.12 | 0.7 | 24 | 35 | 12 |
| and Retort Stand | 2 | 23.12 | 27.12 | 0.2 | 25 | 25 | 10 |
| Ave | - | - | - | 0.45 | - | - | 11 |
| | | | | | | | 50 |
| | | | | | | | 10.2 |
| | | | | | | | 5 |

2. Showing full working, calculate the molar heat of combustion of ethanol for the most accurate experiment. (The molar heat of combustion of ethanol is $1367\ kJ\ mol^{-1}$). (5 marks)

$$\begin{aligned}
 q &= mC\Delta T & \text{molar heat of combustion} &= 8.4\ kJ \\
 &= 50\ g \times 4.18\ J\ g^{-1}\ K^{-1} \times 40\ K & & 79 \times 10^{-3}\ mol \\
 &= 8360\ J & & = 1062.9\ kJ\ mol^{-1} \\
 &= 8.4\ kJ & & = 1.1 \times 10^3\ kJ\ mol^{-1} \\
 n(C_2H_5OH) &= 0.95 & & 4 \\
 &= \frac{120.788}{100} & & \\
 &= 0.0079\ mol & & \\
 &= 7.9 \times 10^{-3}\ mol & & 9
 \end{aligned}$$

3. Analyse your results to describe whether the choice of equipment had any effect on the accuracy of your experiment. (4 marks)

For the 'control' setup, the value for ΔH obtained was 2.2×10^2 (kJ/mol). This

then gives a percentage difference of $\frac{|2.2 \times 10^2 - 1367|}{1367} = 83.9\%$ ✓

For the '80ml beaker' setup, the percentage difference was $\frac{|1.8 \times 10^2 - 1367|}{1367} = 86.8\%$ ✓

For the 'tripod and gauze mat' setup, the percentage difference was

$$\frac{|1.7 \times 10^2 - 1367|}{1367} = 87.6\%$$

These levels of inaccuracy indicate that whilst none of the tests came close to reaching the data book value, the difference between them is quite small and so it can generally be said that the choice of equipment had a negligible effect on the ~~accuracy~~ accuracy of the ~~the~~ results obtained. However, the 'control' setup using just the calorimeter was marginally more accurate and this can probably be attributed to the better thermal conductivity of the calorimeter ^{as opposed to the beaker} and the lack of other equipment (the tripod and gauze) that may have absorbed a significant amount of the heat produced by the combusting ethanol. ~~When~~ When considering the massive ~~the~~ differences ~~to~~ in relation to the data book value, however, random errors (including reading errors of the thermometer ~~and~~, reaction times with the stopwatch and how evenly the heat given off was distributed over the apparatus) ^{and} and systematic errors (including improperly calibrated thermometers and scales (unlikely) ~~were~~ were likely to blame, producing results that were highly inaccurate (not to mention unreliable).

*~~ideally~~, ideally, the heat given off by the spirit burner would be distributed evenly ~~to~~ over the apparatus such that in each ~~set~~ separate apparatus/setup, ~~as~~ the same amount of heat was reaching the water, to allow for ~~as~~ greater reliability and accuracy.

*~~Also~~, ~~also~~, incomplete combustion could be considered a random error

✓ 4.

4. Draw a scientific diagram to show how you set up your experiment for the most accurate result you achieved. (4 marks)

Apparatus for the determination of the heat of combustion of ethanol
(using the 'control' setup with copper calorimeter and retort stand)

